

regretted that the type of lamp illustrated is not the one sold in this country. In other places there is an apparent want of knowledge of recent progress, as, for example, where the oscillograph is spoken of as an instrument of little value, the point-to-point method being described as more practical. These, however, are minor blemishes, such as must be expected in a comprehensive work in which different branches are not written by separate experts. On the whole the book is to be commended; the illustrations and curves are good and well selected.

The last hundred pages of the volume deal with the subject of photometry; all the more important types of photometer are described and illustrated, and the various standards of light are carefully considered. It is perhaps to be regretted that this part of the book should refer more especially to gas photometry, since the remainder is devoted to electric lighting; but then it is altogether somewhat surprising to find a book on electric lighting forming one volume of a series on chemical technology. M. S.

Die empiristische Geschichtsauffassung David Humes, mit Berücksichtigung moderner methodologischer und erkenntnistheoretischer Probleme. Eine philosophische Studie von Dr. Julius Goldstein. Pp. 57. (Leipzig: Verlag der Durr'schen Buchhandlung, 1903.) Price 1.60 marks.

THIS essay may be described as a chapter in the history of applied philosophy. In Hume the author sees an unique example of the philosopher applying his own principles to history. In this case the experiment was of little advantage to history. Hume's well-known views on causation, the self, and uniformity leave history destitute of any "inner essence," individuals or real meaning.

The author relieves these somewhat trite observations by concrete examples from Hume's "History of England." Apart from these, the essay has been, in the main, anticipated by Leslie Stephen's "English Thought in the XVIIIth Century." Perhaps we should not forget that this is a German book. Its value lies solely in focusing attention on Hume as an example of the way history should not be written. The real value of Hume's work is hardly touched; he is ranked above Voltaire, but shares with the Enlightenment the glory of having failed well. As to the question of method, there is here only a negative contribution. Not only has the failure of Hume and the Enlightenment left chaos, but the author leaves it quite an open question how history is to become a science. That may be wisdom, but then the title seems disproportionate. In the references to Green and Grose for P.H. (*passim*) read T.H. On p. 51 (note) the reference is i. S. 378, &c. (not ii.). Siegart is, of course, Sigwart (p. 11). "Aepinus" (p. 39) and the Englishman "Marivaud" (p. 56) are scarcely recognisable, but probably symbolise "Aquinas" and "Merivale." G. S. B.

Arithmetic. Part i. By H. G. Willis, M.A. Pp. viii+256+1. (London: Rivingtons, 1903.) Price 1s. 4d.

THIS collection of examples on the simpler parts of arithmetic is arranged in a convenient and workable manner. The exercises are divided into thirty-nine groups, each containing work enough for two or three lessons; there are, moreover, duplicate sets of exercises which can, if necessary, be used in alternate terms. Oral questions are set at the beginning of each exercise. A few examination papers, tables of reference, and answers are given at the end of the book. The volume is likely to prove useful for junior forms.

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LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

Action of Live Things in Mechanics.

DR. HOBSON (p. 611) appears to hold the view that if dynamical laws are exact and irrefutable, the universe must be a completely determined mechanical system, with only one, and that a necessary, solution.

I hold, on the other hand, that though dynamical laws when properly stated are perfectly true, they do not cover the whole region of existence, and that, accordingly, it is possible for live things to affect the motions of matter in an unpredictable and capricious manner, though always in accordance with the laws of motion.

Dr. Hobson says, or implies, that they cannot so interfere without destroying the complete validity or supremacy of mechanical laws, and that they may as well upset the law of the conservation of energy as any other.

I reply that it is a question of fact whether they do or not. Experience seems to me to prove:—

(a) That live animals do introduce fresh considerations and do disturb things—do not take the path of least resistance, for instance; they are actuated by all sorts of non-mechanical motives, climbing the Matterhorn when there is no necessity, and building structures which would not otherwise be built.

(b) That in so doing they never run counter either to the conservation of energy or to any other fundamental mechanical law; they utilise the mechanical energies which lie ready to their hands, directing them, but leaving their amount unaltered.

[I emphasise the energy aspect because I so often find philosophers assume that any interference of life with inanimate matter must contradict the conservation of energy, or else must involve the doctrine that life itself is a form of energy.]

I ask Dr. Hobson to admit that a unique solution of all future material motions is only possible in a problem from which all other aspects of the universe have been abstracted, so that we limit ourselves by hypothesis to a purely dynamical system.

There are many things in the universe beside mechanics, some of which, by odd chance, are enumerated in a footnote accidentally occurring below Dr. Hobson's letter. For simplicity it is customary to eliminate all these from dynamical problems. But the questions at issue are:—

(1) Whether any of these things can interact with or influence a dynamical system at all.

(2) Whether they can so interact without upsetting or contradicting any fundamental dynamical laws.

I wish to answer both these questions in the affirmative. But it must be understood that by "dynamical laws" I mean the fundamental ones—let us say those of Newton. I do not mean modern generalisations or comprehensive summaries, like the principle of Least Action, the applicability of which can only be postulated on certain simplifying assumptions—assumptions or abstractions which, in the present instance, merely beg the question in dispute.

If Dr. Hobson does not agree with this, I trust he will give us the benefit of his further criticism.

May 2.

OLIVER LODGE.

The Glorification of Energy.

PROF. TAIT, whenever he wrote of the principle of the conservation of energy, almost invariably spoke of it as the "grand" principle of conservation of energy; and, following his lead, all but the most sober mathematicians use the laudatory adjective when they write about this particular physical principle.

It may not be altogether superfluous to point out that there are other principles equally entitled to the epithet "grand." For example, there is the "grand" principle of the conservation of matter; there is the "grand" principle of the conservation of force, the sum total (algebraic) of which in the universe is zero, according to Newton's

Axiom ii.; there is the "grand" principle of the conservation of momentum, the algebraic sum total of it along any direction in the universe being constant (and possibly zero) by Newton's Axiom iii.; as well as the "grand" principle of the conservation of energy.

Now I hold that it is invidious to apply laudatory epithets of various degrees to these principles; but it may not be wrong to point out that in many respects the momentum principle has a marked advantage over the energy principle, the former being very often very easily, and without any danger of error, applicable, while the latter (owing to the elusiveness of energy) is full of danger to the unwary.

Postulating now the existence of spirit, we find a difficulty in defining this entity; but no greater mystery attaches to it than that involved in matter. The spiritualists imagine that they gain something by calling matter hard and contemptuous names—"mere" matter, "gross" matter, "mere gross" matter, &c. The names are harmless, and do not assist ideas in any way.

Postulating, then, the existence of a spiritual domain, the crucial question arises: does Newton's Axiom iii. hold for the interaction of the domains of matter and spirit? If it does, there is no dynamical principle interfered with; in the dual domain there are conservations of force, of momentum and of energy; but in the physical universe, taken separately, neither force nor momentum would be conserved, although energy might. On the other hand, if Newton's Axiom iii. does not hold for the interaction of the two domains, no principle of conservation could be enunciated for either domain, or for the system of the two together.

Sir Oliver Lodge is anxious to make out the existence of a spiritual domain, and to allow it a certain influence on the physical, which influence, however, "perturbs physical and mechanical laws no whit." How does he effect this? By assuming (to put the thing into mathematical language) that the forces exerted on material things by the spiritual are forces which do no work—such as are reactions of smooth fixed surfaces, tensions of inextensible cords, &c. These are sometimes called "deviating" forces. Sir Oliver calls them "guiding and controlling" forces. But it matters not what they are called, they fail in their object. They allow, indeed, the physical universe to keep its sum total of energy intact, but they infallibly alter its total momentum and total force in every direction.

When Sir Oliver says "guidance and control are not forms of energy, and their superposition upon the scheme of physics perturbs physical and mechanical laws no whit," he says what is perfectly true of any conceivable forces—whether merely "guiding" or not. However force may be produced on a material particle, the effect on the particle will certainly be in accordance with Newton's Axiom ii.; so that, in the sense in which Sir Oliver's statement is true, there is no necessity to postulate that spiritual forces are forces which act on matter but do no work.

It is a physical and mechanical law that when any system of material particles is subject to no forces but its own internal forces, the centre of mass of the system is either at rest or in uniform motion in a right line, and also that its sum total of energy, kinetic and dynamic, is constant. But if Sir Oliver Lodge implies that *both* of these results can remain unaltered if that material system is acted on by spiritual forces, he is certainly wrong. His deviating or "guiding," spiritual forces can leave the total energy (kinetic and dynamic) of that material system unaltered, but they must inevitably interfere with the rest, or constant motion, of the centre of mass. Many of his readers may take this meaning out of his words; but I am sure that he cannot intend to be thus understood.

It seems to me that Dr. Hobson in his letter on the subject has done well to direct attention to the real status of the "grand" principle of the conservation of energy.

GEORGE M. MINCHIN.

Coopers Hill, Englefield Green, Surrey.

Psychophysical Interaction.

As a psychologist I have read with deep interest Sir Oliver Lodge's paper in your issue of April 23, and I write to ask him to make clear some points which his paper leaves obscure to my mind. Those of us who are not mathematicians feel themselves to be very much at the mercy of

those who are, and we can only beg the physicists to remember our infirmity and to put their statements before us in the clearest, simplest, and most carefully chosen language. Sir Oliver Lodge, as Clerk Maxwell did before him, throws out to psychologists the suggestion that mind may act upon body by exerting guidance without doing work. Such guidance, we are told, may be effected by the application of force to moving masses in the nervous system in directions perpendicular to the direction of the movements of those masses. "Guidance is a passive exertion of force without doing work; as a quiescent rail can guide a train to its destination, provided an active engine propels it." This is the sentence that I find so indigestible. And my confusion is but increased by Sir Oliver Lodge's further illustrations. He distinguishes two kinds of force. "Force in motion is a 'power,' it does work and transfers energy from one body to another. But a force at rest—a mere statical stress, like that exerted by a pillar or a watershed—does no work, and alters no energy; yet the one sustains a roof which would otherwise fall, thereby screening a portion of ground from vegetation; while the other deflects a rain-drop into the Danube or the Rhine." And, again, we read that life can exert "the same kind of force which can constrain a stone to revolve in a circle instead of in a straight line; a force like that of a groove or slot or channel or 'guide.'" My first question is, Is it fair to say that the pillar supporting the roof exerts a force in the same sense as the rail which guides the train, the roof which guides the rain-drop, or the hand which holds the string? In the first case there is no motion, and therefore no change of direction of motion, no alteration of energy; in the other cases there is motion and alteration of direction of motion. Secondly, is it fair to call the rail quiescent? In guiding the train round a curve does not the rail, and the mass to which it is made fast, suffer an acceleration or a change of motion in the direction opposite to that of the train? When I swing round a heavy ball on a string, and feel it pulling my hand centrifugally, and when by muscular effort I resist the pull, is that "a passive exertion of force without doing work"? Or, if the string is fastened to the end of an upright pole, is there not movement of the mass to which the pole is fixed in the direction opposite to the deflection of the movement of the ball? Every kind of mechanical guidance that I can picture to myself seems to imply action and reaction, change of direction of one momentum seems to imply always an opposite change of direction of an equivalent momentum. This is, I suppose, the mechanical law of conservation of momentum, of which Prof. James Ward tells us that it is incompatible with the conception of guidance without work. I ask Sir Oliver Lodge whether we are to understand that he is prepared to throw this one mechanical law to the wolves in order to preserve the rest of the creed of the physicists unharmed by Prof. Ward's attack? Or are we to understand that he repudiates the law of conservation of momentum *in toto*? In that case, I ask him to describe for us clearly a single case of mechanical guidance in which momentum is not conserved, or, since my use of the phrase may be technically incorrect, I ask him to describe a case of change of direction of motion of any mass produced without expenditure of energy or opposite change of direction of motion of other mass or masses.

I submit that Sir Oliver Lodge abstracts from the idea of motion the attribute of direction in space, and that such abstraction is illegitimate, save for certain purely theoretical purposes. All motion has direction in space, which would seem to be an essential element in all considerations of energy values. Sir Oliver tells us that life and mind cannot generate energy, though they can guide moving masses by exerting forces perpendicular to the direction of motion. But consider, then, the following case. Imagine a universe consisting of two inert masses flying through empty space in the same direction and at the same rate, and a soul contemplating them. That universe would be devoid of energy. Then suppose the soul to exert a force upon one of the two masses, perpendicularly to its direction of motion, so as to swing it round through a semicircle until it rushes to meet the other mass. The soul, by "guidance," has then created energy, and I take it that the same considerations would hold true in our more complex universe.